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6. AUTHOR(S)
Jitendra K. Tugnait

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES)
Auburn University
Dept. of Electrical Engineering
Auburn, AL 36849

8. PERFORMING ORGANIZATION REPORT NUMBER
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13. ABSTRACT (Maximum 200 words)

This research project is concerned with two distinct aspects of analysis and processing of signals received at multiple sensors from multiple sources when the operating environment is highly uncertain and unstructured. In part I, a general approach based upon an independent component decomposition (ICD) is sought to be investigated involving as few assumptions as possible compared to existing literature. The approach is sought to be developed in conjunction with specific, useful applications such as space and time diversity multiaccess/multiuser digital communications and multitarget tracking using multi-platform multisensor arrays. In part II focus is on maneuvering target tracking using kinematic models. This report describes the progress made on the above two aspects of the project. Details are provided in attached copies of 16 papers − 10 journal articles (accepted/submitted) and 6 conference papers.

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Multichannel/Multisensor Signal Processing In Uncertain Environments With Application To Multitarget Tracking

This research project is concerned with two distinct aspects of analysis and processing of signals received at multiple sensors from multiple sources when the operating environment is highly uncertain and unstructured. In part I, a general approach based upon an independent component decomposition (ICD) is sought to be investigated involving as few assumptions as possible compared to existing literature. The approach is sought to be developed in conjunction with specific, useful applications such as space and time diversity multiaccess/multiuser digital communications and multitarget tracking using multi-platform multisensor arrays. In part II focus is on maneuvering target tracking using kinematic models.

WORK COMPLETED AND IN PROGRESS ("near future") Progress has been made on the following major aspects of the project:

1. **TRACKING MANEUVERING TARGETS USING MULTIPLE KINEMATIC MODELS:** We have investigated a new method (interacting multiple model (IMM) fixed-lag smoothing) for tracking a single maneuvering target in a "clean" environment (no clutter). This work has been reported in [6] and [12]. We have extended this approach to tracking a single maneuvering target in clutter in [7] and [16]. Application of this technique to tracking multiple maneuvering targets in clutter is reported in [8]. In all of the above cases, the proposed approaches yield much improved performance when compared to filtering at the cost of a slight delay (one or two sampling intervals).

   Currently work is in progress to exploit smoothing based results for filtering (i.e. no delay in state estimation).

2. **INDEPENDENT COMPONENT DECOMPOSITION AND ITS APPLICATIONS:** Here we have investigated several approaches for independent source separation, equalization, channel estimation and independent component decomposition. The results have been reported in refs. [1]-[5], [9]-[11] and [13]-[15]. The next step is to focus exclusively on multiple sources and performance analysis.

Journal Articles Submitted/Accepted

[1] J.K. Tugnait, "On linear predictors for MIMO channels and related blind identification and equalization," *IEEE Signal Processing Letters*, vol. SPL-5, pp. 289-291, Nov. 1998.

[2] J.K. Tugnait, "On blind separation of convolutive mixtures of independent linear signals in unknown additive noise," *IEEE Trans. Signal Processing*, vol. SP-46, pp. 3117-3123, Nov. 1998.

[3] J.K. Tugnait and Bin Huang, "Second-order statistics-based blind equalization of IIR single-input multiple-output channels with common zeros," *IEEE Trans. Signal Processing*, vol. SP-47, pp. 147-157, Jan. 1999.

[4] J.K. Tugnait, "Adaptive blind separation of convolutive mixtures of independent linear signals," (invited paper), *Signal Processing* (the EURASIP Journal), vol. 73, Issue 1-2, pp. 139-152, Feb. 1999.

[5] J.K. Tugnait, 'Multistep linear predictors-based blind equalization of FIR/IIR single-input multiple-output channels with common zeros," *IEEE Trans. Signal Processing*, vol. SP-47, pp. 1689-1700, June 1999.

[6] B. Chen and J.K. Tugnait, "An interacting multiple model fixed-lag smoothing algorithm for Markovian switching systems," submitted to *IEEE Trans. Aerospace & Electronic Systems* on 2/98, revised 2/99.

[7] B. Chen and J.K. Tugnait, "Multisensor tracking of a maneuvering target in clutter using IMMPDA fixed-lag smoothing," submitted to *IEEE Trans. Aerospace & Electronic Systems* on 10/98.

[8] B. Chen and J.K. Tugnait, "Multisensor tracking of multiple maneuvering targets in clutter using IMM/JPDA fixed-lag smoothing," submitted to *Automatica* on 2/99. [Also submitted to the *1999 IEEE Conf. on Decision & Control*, Dec. 1999.]

[9] J.K. Tugnait and Bin Huang, "On a whitening approach to partial channel estimation and blind equalization of FIR/IIR multiple-input multiple-output channels," submitted to *IEEE Trans. Signal Processing* on 8/98, revised 3/99.

[10] J.K. Tugnait and Bin Huang, "Multistep linear predictors-based blind identification and equalization of multiple-input multiple-output channels," submitted to *IEEE Trans. Signal Processing* on 10/98.

Conference Presentations & Proceedings Papers

[11] J.K. Tugnait, "On multi-step linear predictors for M.I.M.O. F.I.R./I.I.R. channels and related blind equalization," in *Proc. 1998 IEEE Digital Signal Processing Workshop*, Paper #110, Bryce Canyon, Utah, Aug. 1998.

[12] B. Chen and J.K. Tugnait, "An interacting multiple model fixed-lag smoothing algorithm for Markovian switching systems," in *Proc. IEEE 37th Conf. Decision & Control*, pp. 269-274, Tampa, FL, Dec. 16-18, 1998.

[13] J.K. Tugnait and B. Huang, "Multi-step linear predictors-based blind equalization of multiple-input multiple-output channels," in *Proc. IEEE 1999 Intern. Conf. Acoustics, Speech, Signal Processing*, Phoenix, AZ, vol. 5, pp. 2949-2952, March 15-19, 1999.

[14] J.K. Tugnait and B. Huang, "Blind channel estimation and equalization of multiple-input multiple-output channels," in *Proc. IEEE 1999 Intern. Conf. Acoustics, Speech, Signal Processing*, Phoenix, AZ, vol. 5, pp. 2707-2710, March 15-19, 1999.

[15] J.K. Tugnait, "A multi-delay whitening approach to blind identification and equalization of SIMO channels," in *Proc. 2nd IEEE Signal Processing Workshop on Signal Processing Advances in Communications*, Annapolis, MD, pp. 223-226, May 9-12, 1999.

[16] B. Chen and J.K. Tugnait, "Multisensor tracking of a maneuvering target in clutter using IMMPDA fixed-lag smoothing," to be presented at the *1999 American Control Conference*, San Diego, CA, June 1999.